MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2018/2019

ETM2046 – ANALOG AND DIGITAL COMMUNICATIONS
(RE)

15 MARCH 2019
9.00a.m – 11.00a.m
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 8 pages with 4 Questions and appendix.
2. Attempt **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

Question 1

a) With the aid of a block diagram, explain the communication system.

[11 marks]

b) Find the Fourier series representation in the form of trigonometric and exponential, for the saw tooth waveform shown in Figure Q1(a).

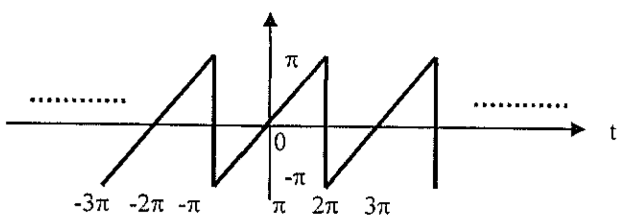

Figure Q1(a)

[6 marks]

c) Evaluate the convolution of the signals $f_1(t)$ and $f_2(t)$ shown in Figure Q1(b).

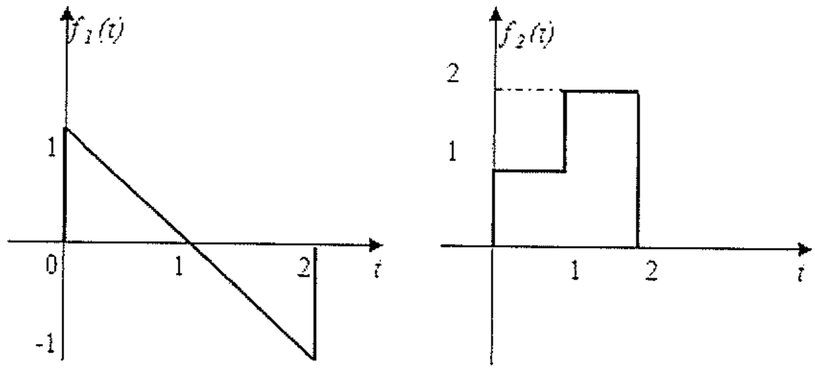

Figure Q1(b)

[8 marks]

Continued...

Question 2

a) Modulation plays an important role in communication system. Describe **THREE** benefits of deploying modulation technique in analog and digital communication system.

[6 marks]

b) A carrier signal $c(t) = A_c \cos(\omega_c t)$ is modulated by a single-tone signal $m(t) = A_m \cos(\omega_m t)$ to form the amplitude modulated signal

$$s(t) = [A_c A_m \cos(\omega_m t)]\cos(\omega_c t)$$

where $A_c = 20 \quad A_m = 4 \quad f_c = 1000\,Hz \quad f_m = 50\,Hz$

(i) Derive an expression for the sidebands of $s(t)$.

[2 marks]

(ii) Sketch the modulated signal $s(t)$. Label the carrier and modulated signal.

[3 marks]

(iii)Sketch the spectra $|M(f)|, |C(f)|$ and $|S(f)|$.

[4 marks]

(iv)Calculate the bandwidth required to transmit the AM signal.

[2 marks]

(v) Show that the total sideband power to the total power in the modulated wave is $\dfrac{m^2}{1+\dfrac{m^2}{2}}$.

[3 marks]

c) A FM modulator is used to transmit a tone message with amplitude of 4 Volts and frequency of 20Hz. Given that the frequency deviation constant for the modulator is 25Hz/V, the carrier wave has amplitude and frequency are 10 Volts and 2000Hz respectively.

Calculate:

(i) The power of FM modulated signal.

[2 marks]

(ii) The approximate bandwidth of the FM modulated signal using Carson's rule.

[3 marks]

Continued...

Question 3

a) The signal shown in Figure Q3(a) is expressed as $v(t) = 5\sin(2\pi 500t) + 5\sin(2\pi 750t)$

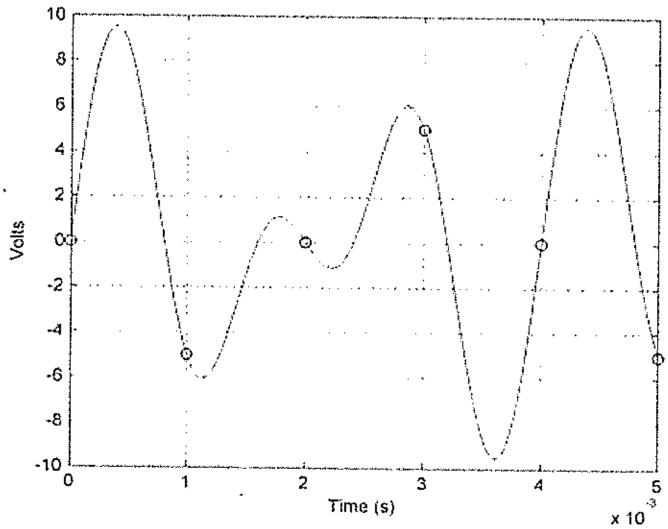

Figure Q3(a)

(i) Determine the sampling rate.

[2 marks]

(ii) Decide whether the signal is optimally sampled or not?

[3 marks]

(iii)Consider data from a source ranges from -1.0 to 1.0. If 8-bit quantization is used, encode the data points as shown in Figure Q3a.

[6 marks]

b) A 1200bit/s bit stream is encoded to a two-level line code signal. The line code is transmitted through a baseband communication system, which implements a sinusoidal roll-off shaping. The shaped line code is then FSK modulated before transmitted over a telephone channel. The FSK signal is to fit into the frequency range of 500 to 2900 Hz of the telephone channel. The carrier is modulated to two frequencies of 1200 and 2200 Hz.

Determine:

(i) The passband bandwidth of the transmission system.

[2 marks]

(ii) The baseband bandwidth of the transmission system (include the effect of roll-off factor).

[4 marks]

(iii)The minimum Nyquist bandwidth.

[2 marks]

(iv)The roll-off factor.

[2 marks]

Continued...

c) A modem has the following specifications: 28.8kbps and 9600 baud. With the given specification, what is the relationship between signal and number of bits per modem?

[4 marks]

Question 4

a) Compare Error Detection Code and Forward Error Control.

[4 marks]

b) The ASCII code has 128 characters, which is binary coded. If certain computer generates 80 000 characters per second.
Find:

(i) The number of bits per character.

[2 marks]

(ii) Bit rate required to transmit the output

[2 marks]

(iii)Minimum bandwidth for transmission

[1 marks]

(iv)Predict he number of bits per character and bit rate if single-error detection is used.

[4 marks]

c) A string consisting of the symbols [A,B,C,D,E] is to be compressed.

ACCCCEABDCCEAAECEAC

Determine:

(i) The optimum encoded symbols by using Huffman coding.

[6 marks]

(ii) Average number of bits per codeword.

[2 marks]

(iii)Entropy of the source.

[2 marks]

(iv)The minimum number of bits required for each codeword if fixed length coding is used.

[2 marks]

Continued...

Appendix I : Table of Bessel Function

n	$\beta = 0$	$\beta = 0.05$	$\beta = 0.1$	$\beta = 0.2$	$\beta = 0.3$	$\beta = 0.5$	$\beta = 0.7$	$\beta = 1$	$\beta = 2$	$\beta = 3$	$\beta = 5$	$\beta = 7$	$\beta = 8$	$\beta = 10$
0	1.000	0.999	0.998	0.990	0.978	0.938	0.881	0.765	0.224	-0.260	-0.178	0.300	0.172	-0.246
1		0.025	0.050	0.100	0.148	0.242	0.329	0.440	0.577	0.339	-0.328	-0.005	0.235	0.043
2			0.001	0.005	0.011	0.031	0.059	0.115	0.353	0.486	0.047	-0.301	-0.113	0.255
3					0.001	0.003	0.007	0.020	0.129	0.309	0.365	-0.168	-0.291	0.058
4							0.001	0.002	0.034	0.132	0.391	0.158	-0.105	-0.220
5									0.007	0.043	0.261	0.348	0.186	-0.234
6									0.001	0.011	0.131	0.339	0.338	-0.014
7										0.003	0.053	0.234	0.321	0.217
8											0.018	0.128	0.223	0.318
9											0.006	0.059	0.126	0.292
10											0.001	0.024	0.061	0.207
11												0.008	0.026	0.123
12												0.003	0.010	0.063
13												0.001	0.003	0.029
14													0.001	0.012
15														0.005
16														0.002
17														0.001

	N		N		N		N
$\beta = 0.05$	1	$\beta = 0.7$	4	$\beta = 5$	10	$\beta = 20$	28
$\beta = 0.1$	2	$\beta = 0.8$	4	$\beta = 6$	12	$\beta = 25$	34
$\beta = 0.2$	2	$\beta = 0.9$	4	$\beta = 7$	13	$\beta = 30$	39
$\beta = 0.3$	3	$\beta = 1$	4	$\beta = 8$	14	$\beta = 35$	45
$\beta = 0.4$	3	$\beta = 2$	6	$\beta = 9$	15	$\beta = 40$	50
$\beta = 0.5$	3	$\beta = 3$	7	$\beta = 10$	17	$\beta = 45$	55
$\beta = 0.6$	3	$\beta = 4$	9	$\beta = 15$	22	$\beta = 50$	61

Appendix II: Table of Trigonometric Identities

$$\sin A \sin B = \frac{1}{2}\left[\cos(A - B) - \cos(A + B)\right]$$

$$\cos A \cos B = \frac{1}{2}\left[\cos(A + B) + \cos(A - B)\right]$$

$$\sin(A + B) = \sin A \cos B + \cos A \sin B$$

$$\cos(A + B) = \cos A \cos B - \sin A \sin B$$

$$\sin^2 x = \frac{1}{2}(1 - \cos 2x)$$

$$\cos^2 x = \frac{1}{2}(1 + \cos 2x)$$

$$\sin\theta = \frac{1}{2j}\left[e^{j\theta} - e^{-j\theta}\right]$$

$$\cos\theta = \frac{1}{2}\left[e^{j\theta} + e^{-j\theta}\right]$$

Continued...

Appendix III: Fourier Transform Pairs

$x(t)$	$X(f)$
$\delta(t)$	1
$\delta(t-t_0)$	$e^{-j2\pi f t_0}$
1	$\delta(f)$
$e^{j2\pi f_0 t}$	$\delta(f-f_0)$
$e^{-at}u(t)$	$\dfrac{1}{a+j2\pi f}$ for $\alpha > 0$
$e^{-at}u(-t)$	$\dfrac{1}{a-j2\pi f}$ for $\alpha > 0$
e^{-at}	$\dfrac{2a}{a^2-(2\pi f)^2}$ for $\alpha > 0$
$rect\,(\frac{t}{T})$	$T\sin c(fT)$
$\sin c(2Wt)$	$\dfrac{1}{2W}rect\left(\dfrac{f}{2W}\right)$
$\Delta\left(\dfrac{t}{T}\right)$	$\dfrac{T}{2}\sin c^2\left(\dfrac{fT}{2}\right)$
$W\sin c^2(Wt)$	$\Delta\left(\dfrac{f}{2W}\right)$
$e^{-\pi t^2}$	$e^{-\pi f^2}$
$\cos(2\pi f_0 t)$	$\frac{1}{2}\delta(f-f_0)+\frac{1}{2}\delta(f+f_0)$
$\sin(2\pi f_0 t)$	$\frac{1}{2}[\delta(f-f_0)-\delta(f+f_0)]$

Continued...

Appendix IV: Fourier Transform Properties

Let $x(t) \Leftrightarrow X(f)$, $x_1(t) \Leftrightarrow X_1(f)$ and $x_2(t) \Leftrightarrow X_2(f)$; and a, b, t_o and f_o scalar quantities.	
Linearity	$ax_1(t)+bx_2(t) \Leftrightarrow aX_1(f)+bX_2(f)$
Scaling ($a \neq 0$)	$x(at) \Leftrightarrow \frac{1}{\lvert a \rvert} X\left(\frac{f}{a}\right)$
Time Shifting	$x(t-t_o) \Leftrightarrow X(f)e^{-j2\pi f t_o}$
Frequency Shifting	$x(t)e^{j2\pi f_o t} \Leftrightarrow X(f-f_o)$
Time Convolution	$x_1(t) * x_2(t) \Leftrightarrow X_1(f)X_2(f)$
Frequency Convolution	$x_1(t)x_2(t) \Leftrightarrow X_1(f) * X_2(f)$
Time Differentiation	$\frac{d^n}{dt^n}x(t) \Leftrightarrow (j2\pi f)^n X(f)$
Frequency Differentiation	$(-jt)^n x(t) \Leftrightarrow \frac{d^n}{df^n}X(f)$
Time Integration	$\int_{-\infty}^{t} x(\tilde{t})d\tilde{t} \Leftrightarrow \frac{X(f)}{j2\pi f}+\frac{1}{2}X(0)\delta(f)$
Frequency Integration	$x(t)u(t) \Leftrightarrow \int_{-\infty}^{f} X(\tilde{f})d\tilde{f}$

End of paper